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Evidence of Russian Development of New Subkiloton Nuclear Warheads

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public statements by Russian scientists and officials since 1993 indicate that the last nuclear warhead designed during the Soviet era was a device tailored for enhanced output of high-energy X-rays with a total yield of only 300 tons.

Judging from Russian writings since 1995 and Moscow's evolving nuclear doctrine, new roles are emerging for very-low-yield nuclear weapons—including weapons with tailored radiation output—and there are powerful advocates for development of such weapons in the country's military and weapons community. The Moscow press claimed that a draft presidential edict from Yel'tsin called for "development of new-generation nuclear weapons."

- Recent statements on Russia's evolving nuclear weapons doctrine lower the threshold for first use of nuclear weapons and blur the boundary between nuclear and conventional warfare. Very-low-yield nuclear weapons reportedly could be used to head off a major conflict and avoid a full-scale nuclear war.

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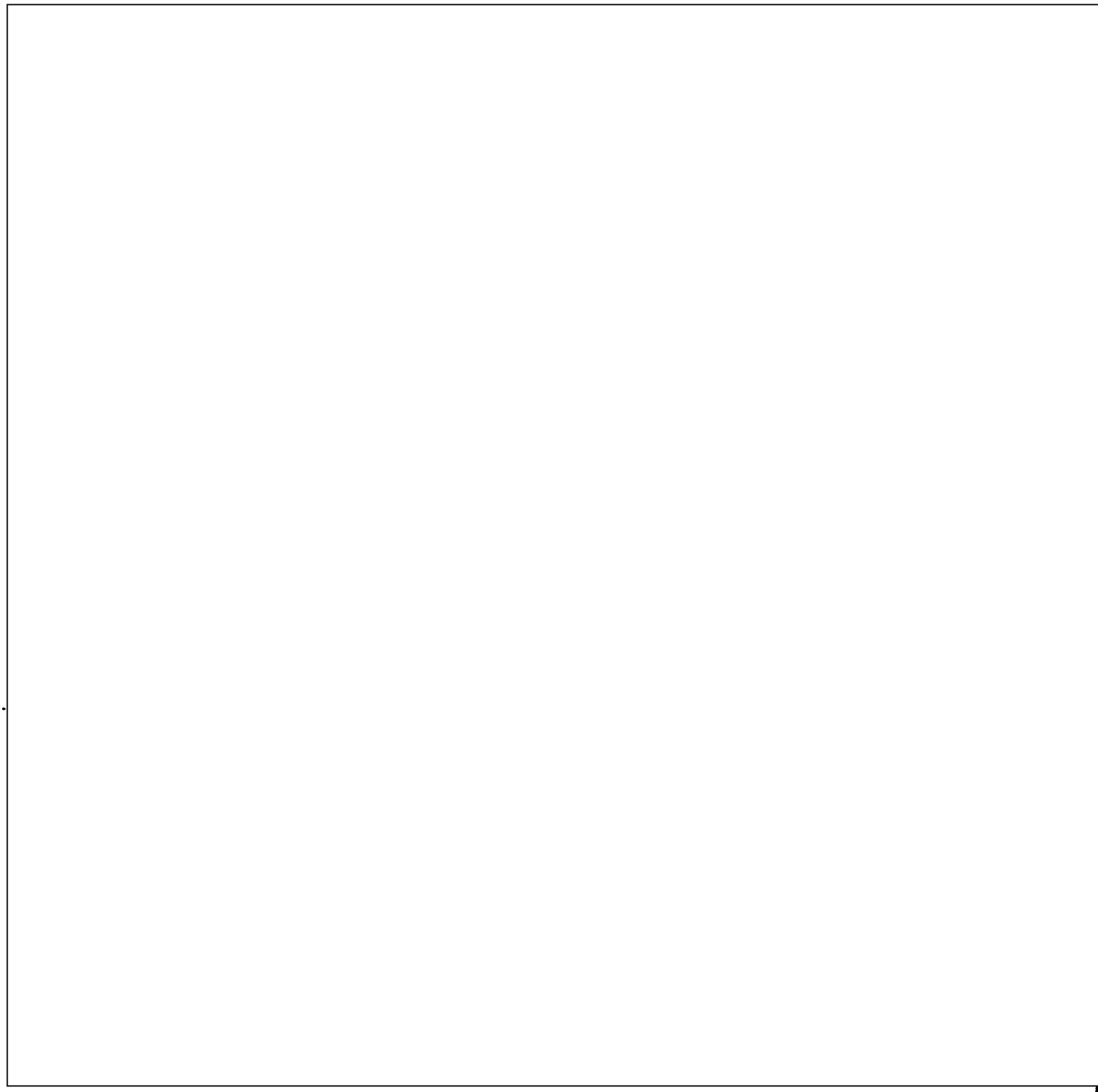


A Perceived Need For "Clean" Very-Low-Yield Nuclear Weapons

public statements by Russian scientists and officials since 1993 indicate that the last nuclear warhead design of the Soviet era was a device tailored for enhanced output of high-energy X-rays with a total yield of only 300 tons.

In the post-Soviet era, the need for subkiloton nuclear weapons with minimal long-term contamination has been argued in the media by senior Ministry of Atomic Energy (Minatom) officials, nuclear weapons scientists, and military academics since the mid-1990s. Advocates often claim to know that the United States is developing the next generation of nuclear weapons and argue that Russia must not lag behind. Somewhat inconsistently, they also cite clean, very-low-yield weapons as an "asymmetric response" to US superiority in conventional weapons. According to Sergei Rogachev, Deputy Director of the Arzamas-16 nuclear weapons design laboratory: "Russia views the tactical use of nuclear weapons as a viable alternative to advanced conventional weapons."

- Senior Russian military officers have advocated the use of highly-accurate, super-low-yield nuclear weapons in Russian military journals such as *Military Thought* and *Armeyskiy Sbornik*. Deputy Commander in Chief of the Strategic Rocket Forces Muravyev stated that to have an effective impact across the entire spectrum of targets, strategic missile systems should be capable of conducting surgical strikes in a wide spectrum of ranges with minimal ecological consequences, which could be achieved with low-yield nuclear weapons.

Soviet Era Development of Tailored - Output Nuclear Devices

Russian development of nuclear devices tailored to enhance certain types of radiation output began during the Soviet period when "clean" nuclear devices—that is with reduced contamination from fission products—were needed for peaceful nuclear explosions (PNE's), according to statements by the developers. Clean PNE devices were in effect the first enhanced-radiation devices produced in Russia and likely precursors of tailored-output devices developed later for both effects testing and weapons development, which involved the same scientists (see appendix B for detailed discussion).

Enhanced-radiation weapons are designed to increase the effective range of gamma, neutron, X-ray, or electromagnetic pulse effects beyond the range of the airblast and fireball effects. Clean PNE devices are designed to minimize contamination from fission products by maximing the fraction of the total yield produced by fusion. The two objectives are achieved by similar design approaches.

Having first developed tailored-output devices for PNE's, Russian scientists then began to investigate the possible weapons effects resulting from radiation enhancement. Russian scientists acknowlege that tests were conducted in the early 1980s to simulate the effects of a US neutron bomb on Soviet naval electronics.

Alexander Shcherbina, a scientist from the Chelyabinsk-70 nuclear weapons design laboratory, told the Russian press in the mid-1990's that a nuclear test involving a subkiloton device tailored for high output of hard X-rays (high-energy X-rays) was planned for 1990 and would have been the culmination of a 20-year effort.

Effects of High-Energy X-Rays

According to the Kazakhstani press, a Soviet effects device was tailored to produce "extremely-high X-ray radiation" or "super-hard X-ray radiation," probably high-energy X-rays that can propagate substantial distances through the atmosphere before being absorbed.

The damage effects of such devices would vary depending on the target and the application, and depending on whether they are deployed in the atmosphere or in space (see appendix C for detailed discussion).

- **Thermal effects:** X-rays interacting with the atmosphere produce blast and thermal effects. High-energy X-rays travel farther before they are absorbed, as do gamma rays.
- **EMP effects on electronics:** The interaction of hard X-rays or gamma radiation with the atmosphere produces a source-region electromagnetic pulse (EMP) that can damage or upset electronics beyond the range of thermal and blast effects.
- **Effects in the atmosphere versus in space:** X-ray effects can be used directly against satellites or ICBMs in space because there is no atmosphere to absorb them. The effects are due to heating and thermomechanical failures caused by rapid energy deposition—particularly from high-energy X-rays.

Response from Yel'tsin?

Yel'tsin had drafted an edict calling for "development of a new-generation of nuclear weapons," according to the Moscow newspaper *Segodnya* in 1998[1]. Fifteen months later, following Russia's April 1999 Security Council meeting, *Segodnya*'s writer Pavel Felgengauer speculated that the new weapons program probably was the next generation of tactical nuclear weapons long advocated by Minatom. The new program reportedly would give Russia the capability to carry out precision, low-yield "nonstrategic" nuclear strikes anywhere in the world. Felgengauer also claimed that Minatom obtained official authorization to implement the program because of increased threat perceptions following NATO's strikes on Yugoslavia.

Nuclear Doctrine for the 21st Century

Coincident with the writings by Russian scientists and military academics, as well as Yel'tsin's edict on next-generation weapons, Moscow's military doctrine on the use of nuclear weapons has been evolving and probably has served as the justification for the development of very-low-yield, high-precision nuclear weapons. Since the dissolution of the Soviet Union, Russia has increasingly relied on its nuclear forces to protect itself from external military aggression. Doctrinal formulations, public statements demonstrate that Moscow considers Russia's nuclear forces as the only means to prevent large-scale, conventional attacks on Russia.

[1] Russia's definition of 3rd generation nuclear weapons, according to *Flag Rodiny*, is: "Special warheads in which, due to their special design, the redistribution of the energy of the explosion occurs in favor of one of the damage-producing factors. Neutron weapons are most common among 3rd generation weapons and have a selective destructive impact." Viktor Mikhaylov's public statements emphasize the low-yield, high-precision features for "surgical" strikes.

- In late 1999, Defense Minister Sergeyev, writing in the Defense Ministry newspaper *Krasnaya Zvezda,* advocated the continued development of advanced military technologies, including weapons based on "new physical principles." Sergeyev stated that these new weapons would transform how armed conflict was conducted and would fundamentally change the perception of parity between military powers. He claimed that only modest resources were needed to acquire such weapons.

- Former Atomic Energy Minister Mikhaylov, other nuclear scientists, military officers, and national security commentators have described these new weapons as blurring the boundaries between conventional and nuclear war. In a 1996 treatise, Mikhaylov advocated developing a new generation of nuclear battlefield arms with relatively low yields that would change the perception of nuclear arms as weapons of mass destruction. In 1999, he claimed that these new-generation nuclear charges would sharply lower the psychological threshold of nuclear weapons use and would increase the likelihood of a nuclear strike in a local conflict, according to an independent Russian military newspaper.

- ***The development of low-yield warheads that could be used on high-precision weapon systems would be consistent with Russia's increasing reliance on nuclear weapons to deter conventional as well as nuclear attacks, especially given widespread perceptions of a heightened threat from NATO and the reduced capabilities of Russian conventional forces.*** Russia has no prospect of restoring its conventional military capabilities in the foreseeable future, nor of matching the West in the procurement and deployment of advanced weapon systems that can be brought to bear at the nonnuclear level.

- ***Defense officials also would be interested in low-yield warheads because of fears that a future conflict could be waged on Russian soil.*** A retired Strategic Rocket Forces general has argued that the damage and casualty effects of Russia's current nuclear arsenal are too high if a future battle occurred on Russian soil. The retired general has speculated that Russia's new warheads would inflict less collateral damage than West's counterpart precision weapons.

- ***These new weapons would also satisfy conditions outlined by military officers to reduce the risk of escalation if Moscow employed limited first strikes.*** Russian military officers have identified the need for demonstration strikes as a warning to an enemy about the country's readiness for full-scale use of nuclear weapons and claimed that these limited strikes would "de-escalate" the conflict. Two colonels urged the employment of single, "nonlethal" strikes against selective targets, which would reduce the risk that an enemy would respond by escalating to an all-out nuclear war, according to an independent Russian military newspaper.

Russia's Evolving Nuclear Doctrine

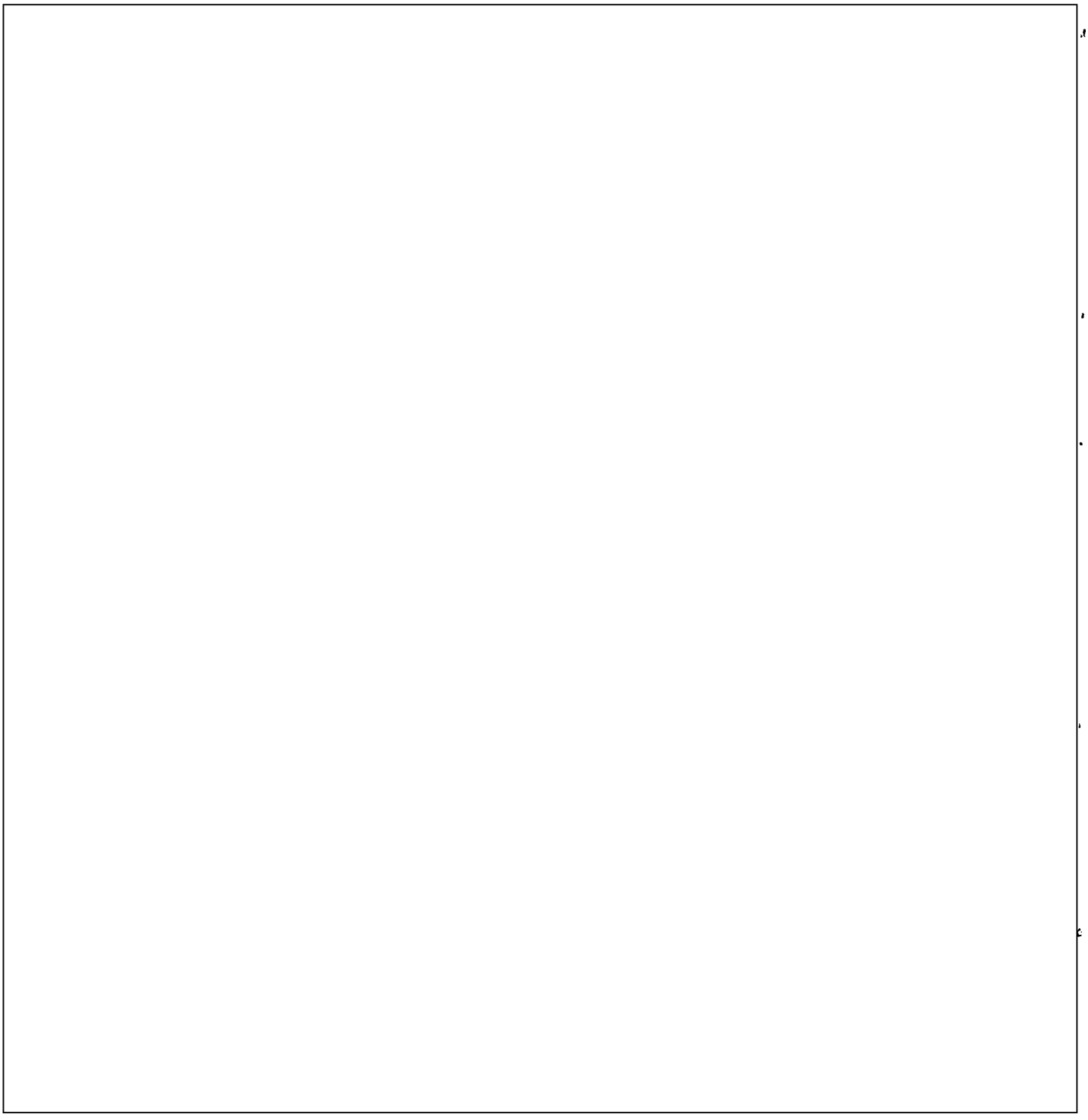
Since the dissolution of the USSR in 1991, Moscow's military doctrine has undergone a major shift with respect to the possible use of nuclear weapons. The deterioration of Russia's conventional military capabilities led to the adoption of a broadened concept of nuclear deterrence as early as the fall of 1992. Russia's nuclear arsenal was invoked to deter any large-scale conventional aggression in addition to nuclear attacks.

This concept in turn necessitated a rethinking of the old Soviet pledge—initially endorsed by President Yel'tsin—that Moscow would never be the first to use nuclear weapons. A November 1993 statement of *Basic Provisions of the Military Doctrine of the Russian Federation* clearly departed from the decade-old pledge never to be the first to use nuclear weapons and adopted a broadened concept of nuclear deterrence covering large-scale, nonnuclear threats to Russia. As a warning to potential adversaries, Moscow indicated it might use nuclear weapons first if an aggressor takes actions to destroy or disrupt operation of Russia's strategic nuclear forces, missile attack warning system, or nuclear and chemical industries.

Other documents, such as the evolving new military doctrine and the National Security Concept papers, outline key aspects of Russian nuclear doctrine and reflect a debate among the political and military elite regarding threats, threat responses, and overall defense resource allocations. These documents demonstrate a hardening of Russian views toward the United States and NATO and reflect Moscow's perception of its diminished international power, its inability to check an increasingly US-dominated unipolar world and anxiety over the reduced strength of Russian conventional forces:

- **Draft Military Doctrine:** In the fall of 1996, the Russian Defense Council reviewed Russian military doctrine as part of an effort to revive military reform. Since late 1996, Russian press reports have repeatedly characterized the new military doctrine as being more explicit about the circumstances under which Russia might initiate the use of nuclear weapons, but also have indicated fundamental disagreements between the Defense Council and the Defense Ministry on nuclear deterrence and the potential use of nuclear weapons. Civilian leaders have been more inclined to stretch the concept of nuclear deterrence to cover conventional threats.

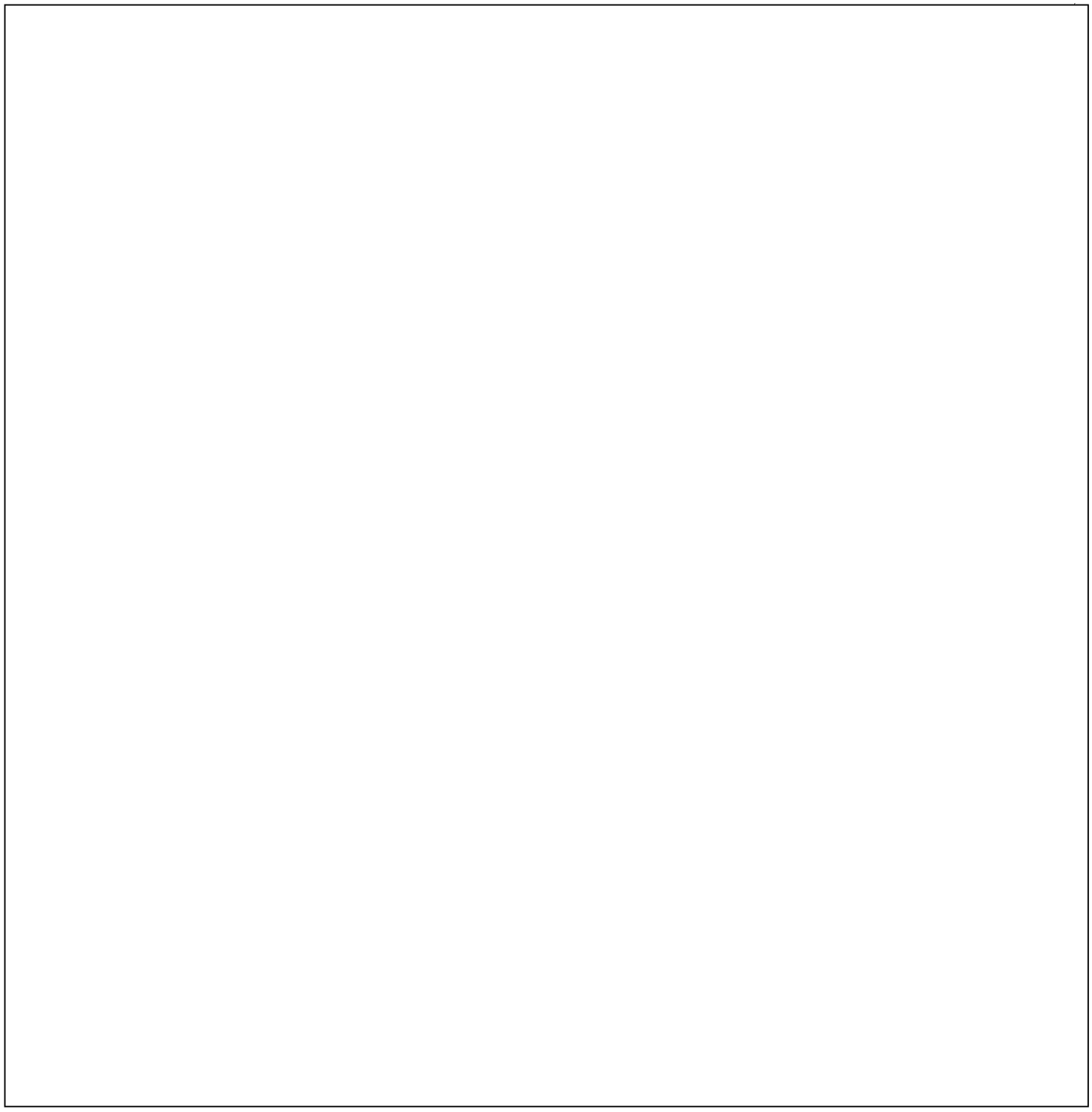
- **National Security Concept:** The 2000 National Security concept places more emphasis on external threats than its 1997 predecessor, which identified internal unrest and the economic situation as the primary threats to the Russian Federation. Acting President Putin publicly endorsed the principle of using "all forces and assets, including nuclear weapons," to repel armed aggression, if all other measures for resolving a crisis are exhausted or prove ineffective.

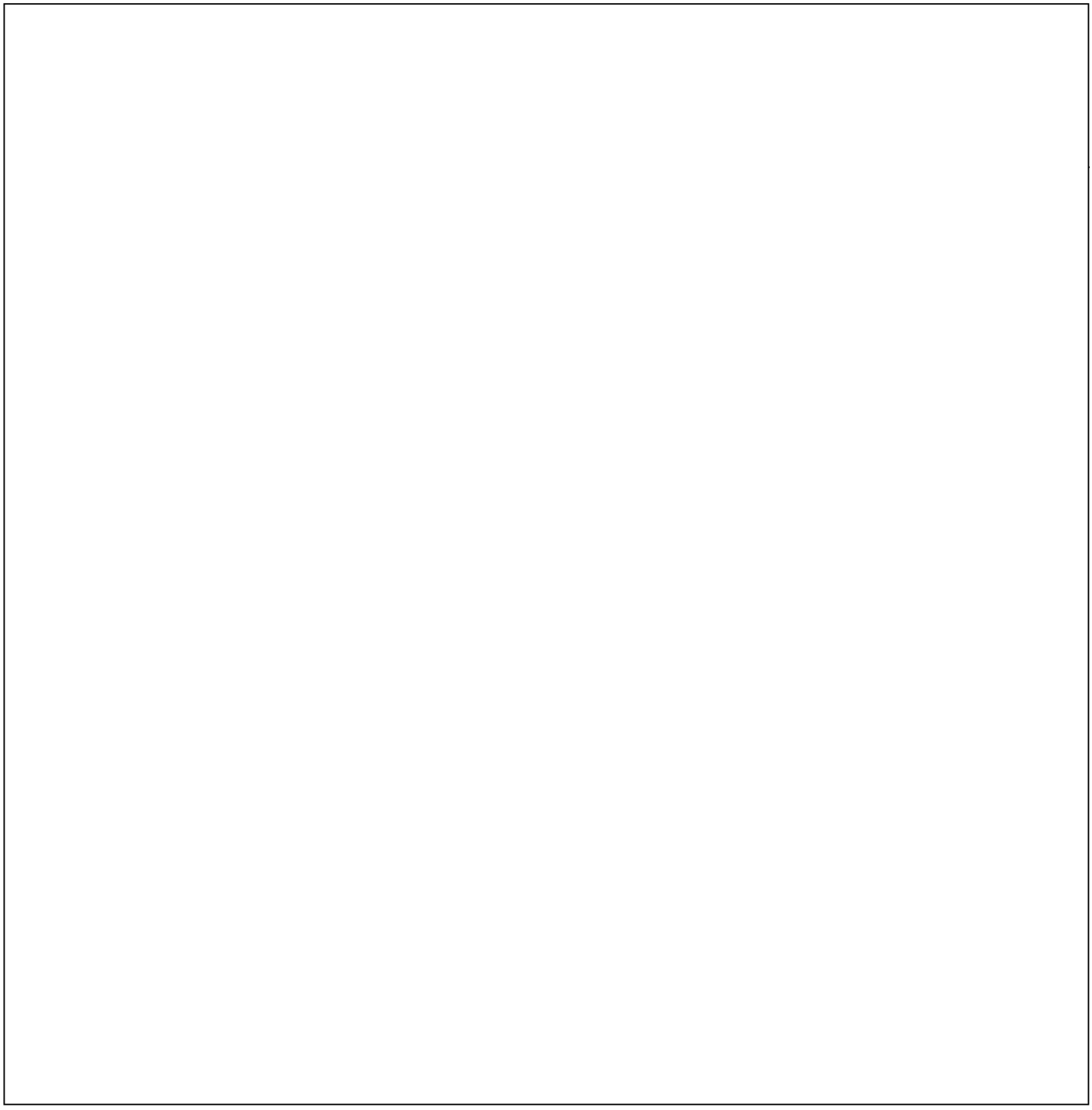


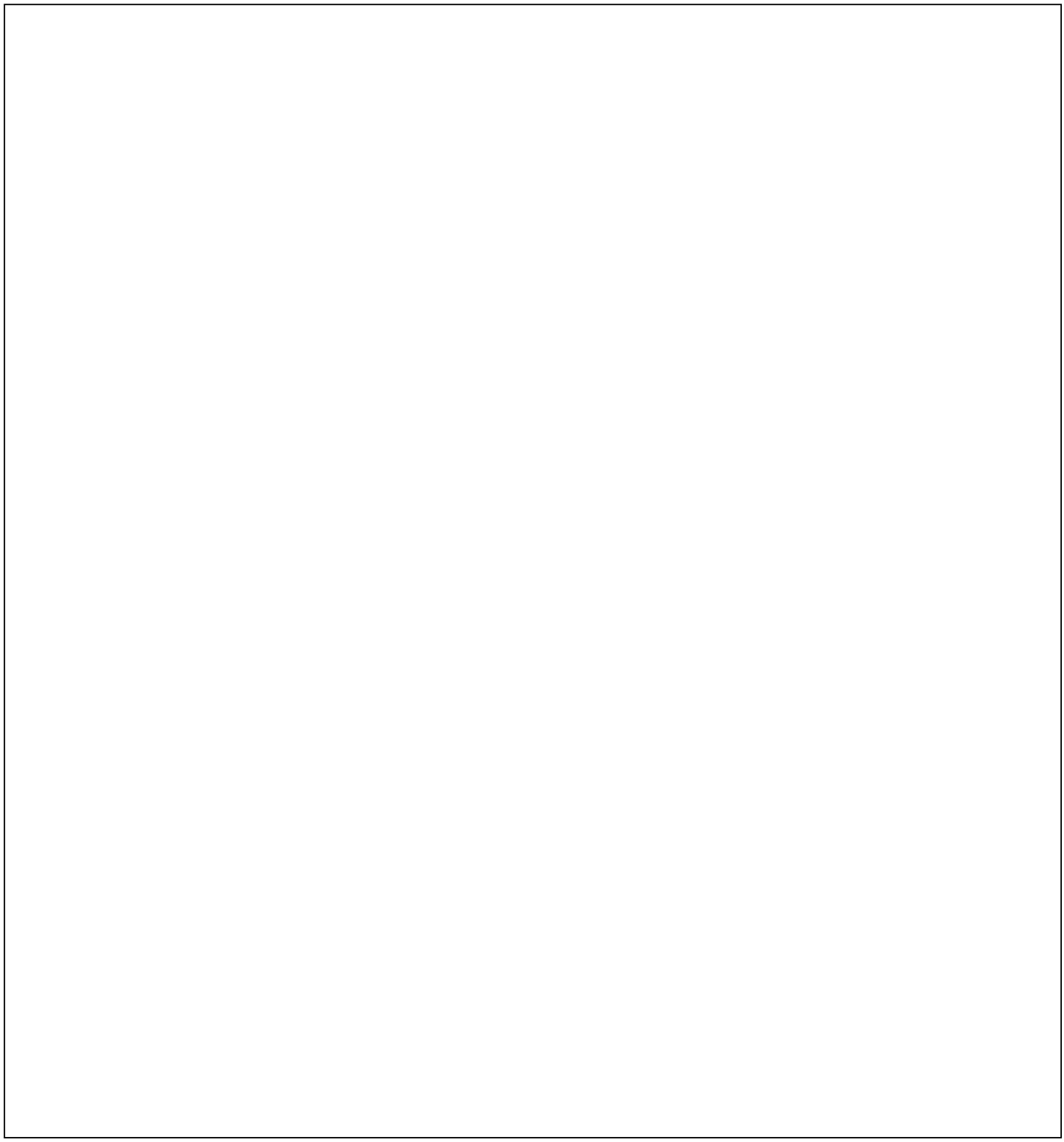
The possible diverse applications for subkiloton nuclear weapons devices range from tactical battlefield weapons to antisatellite weapons. Media reports have noted that current modernization plans will affect Russia's entire stockpile, from tactical to strategic weapons. According to the December 1999 issue of the Army Journal *Armeyskiy Sbornik:*

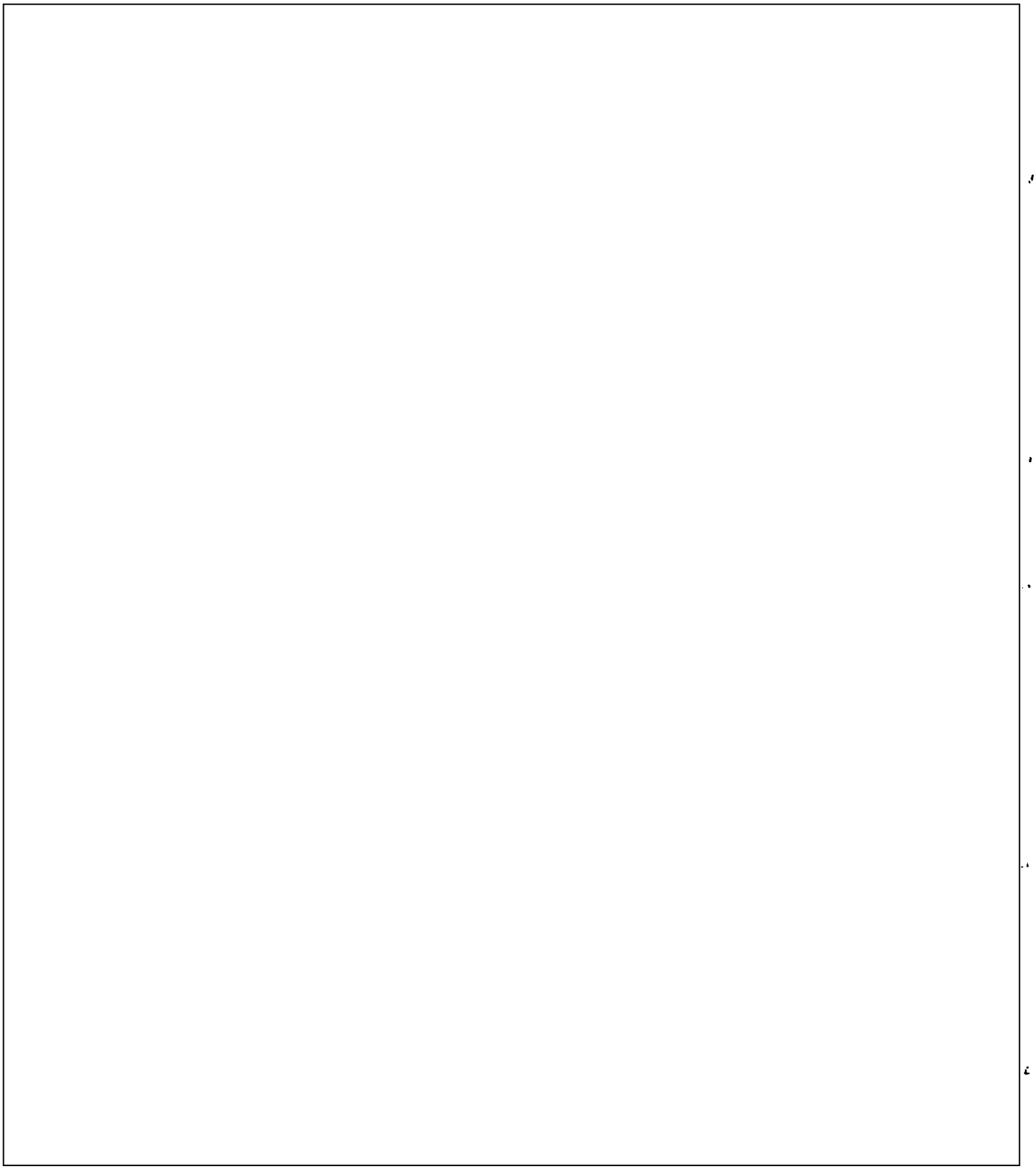
> "For an effective impact across the entire spectrum of targets, strategic missile systems should be capable of conducting 'surgical' strikes over a wide spectrum of ranges in the shortest period of time with minimal ecological consequences. This is achieved by using highly accurate, super-low-yield nuclear weapons, as well as conventional ones, and requires the highest accuracy."

The range of applications will ultimately be determined by Russia's evolving nuclear doctrine, and could include artillery, air-to-air missiles, ABM weapons, anti-satellite weapons, or multiple rocket launchers against tanks or massed troops.









Appendix C: Tailored Output and Effects

When a nuclear device explodes, the energy is emitted in several different forms. For a pure-fission weapon, about 70 percent to 80 percent of the energy is emitted in the form of "soft" X-rays (that is, at the lower end of the X-ray frequency spectrum), but immediately converted to air blast and heat (the fireball) by interaction with the atmosphere. The remaining energy is released as various forms of nuclear radiation—both prompt (gammas and neutrons within the first minute of the detonation) and residual radiation emitted over a period of time.

The objective of tailored output devices is to increase the effective range of gamma, neutron, or X-ray effects beyond the range of the airblast and fireball effects.

- **Effects on personnel:** Personnel exposed to a nuclear explosion may be killed or suffer injuries in various ways, but casualties are primarily caused indirectly by airblast, thermal radiation (both caused by the soft X-ray output), and nuclear radiation (the gamma and neutron radiation), rather than by the effects produced by a tailored-output device. The frequency and severity of the effects on personnel depend on the weapon yield, height of burst, atmospheric conditions, the protection afforded by any shelter, and the general nature of the terrain. Although casualties may be produced by a single effect, such as nuclear radiation, it is likely that they will result from a combination of effects.

- **EMP effects on electronics:** The interaction of prompt gamma or hard X-ray radiation from a nuclear detonation with the atmosphere produces a source region electromagnetic pulse (SREMP) whether a detonation is on or near the surface of the earth or an airburst. The SREMP environment of a surface burst can extend out to a radius of several kilometers from the burst and a radiated environment can extend for larger distances. For a high-yield airburst, the SREMP environment can extend from approximately 5 to 100 km depending on altitude and yield. Electronic circuits and systems may be damaged or upset by an electromagnetic pulse (EMP), which occurs because an electromagnetic field interacts with metallic conductors, inducing electric currents on and in them. EMP energy coupled to the interior of a susceptible system can cause adverse effects ranging from transient, resettable, or permanent upset of digital logic circuits to permanent damage to electronic components. Electronics can be hardened to the effects of EMP in general, however, the protection approach for SREMP will depend on the overall hardness of the system to other nuclear effects—such as blast, thermal and transient radiation effects on electronics (TREE—see below)—and the system's mission.

- **Effects in the atmosphere versus in space:** A nuclear device detonated outside of the atmosphere (exoatmospheric burst) can be a direct threat to satellites and ICBMs/SLBMs. The X-rays produced by nuclear weapons are strongly absorbed in air which is not the case in the exoatmosphere. Thus a space system within line-of-sight of an exoatmospheric detonation will be directly exposed to the X-ray, gamma, and neutron radiation emitted by the weapon. The space systems exterior is exposed directly to the incident radiation without any attenuation. In fact, the damage done by X-rays on a space system is likely to be significantly more than the damage done by the neutrons or gammas. The principal effects of X-rays in aerospace systems can be divided into structural effects TREE, and system generated electromagnetic pulses (SGEMP).

SGEMP—SGEMP is usually an X-ray driven phenomenon and is generally of importance only for exoatmospheric systems. SGEMP effects can occur throughout the system at progressively deeper levels within it external to the structure of individual component packages. Conventionally, it is divided into subcategories which include external SGEMP, internal EMP (IEMP) and so forth. External EMP are the fields and surface currents, produced by the impinging radiation, that couple to the interior.

TREE—Electronic systems may encounter nuclear radiation environments from several different sources. Space systems must withstand the effects of natural radiation environments consisting of electrons and protons. Military systems designed for use during a nuclear attack must withstand the environments generated by a nuclear weapon detonation. The primary effects of all these environments on electronic semiconductors are frequently referred to as Transient Radiation Effects on Electronics, or TREE. Even if the environment that is "transient," the effect may be permanent.